APPENDIX B

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I N T E R O F F I C E C O R R E S P O N D E N C E

Richmond, Virginia

To: Warren Claflin Date: May 18, 1989

From: Douglas D. McRae

Subject: 8-Port Sidestream Monitor Calibration.

I have checked the operation of the 8-port sidestream monitor with a series of calibrated neutral density filters purchased from Oriel Corp. (Stratford, CT). The filters are specified in terms of their optical density. Optical density is defined as:

$$O.D. = \log_{10}(1/T),$$

where T is the fraction of light transmitted through the filter. The neutral density filter calibrations at 550 nm were used for calculating the expected transmission values. Before the calibration check was performed the zero and full scale positions were adjusted on the strip chart recorder. Three runs were made for each of the transmission values listed in Table 1. The measured transmissions from both the strip chart recorder and the computer data acquisition system are shown in Table 2. The data from the strip chart recorder were determined to the nearest 0.5%. The normal operating procedure was followed for each run with the full scale photodiode reading being adjusted to between 0.998 and 1.003 each time.

TABLE 1

Expected % Transmission	Filter(s) (Optical Density)
0	Shutter closed
0.9	2.03[1]
12.6	0.90
20.0	0.70
31.6	0.50
51.3	0.29[2]
61.7	0.21
83.2	0.08
100.0	Shutter open, no filters

[1]Combination of two filters with 1.13 and 0.90 densities.
[2]Combination of two filters with 0.21 and 0.08 densities.

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TABLE 2

Run	Expected % Transmission	Measured % Transmission (Computer)	Measured % Transmission (Strip Chart)
1	0.0	-	0.0
2	0.0	-	0.0
3	0.0	0.3	0.0
4	100.0	104.7	100.0
5	100.0	100.7	100.0
6	100.0	100.9	100.0
7	83.2	83.7	84.0
8	83.2	85.1	84.0
9	83.2	85.0	84.0
10	61.7	64.1	61.5
11	61.7	61.0	61.5
12	61.7	63.6	61.0
13	51.3	52.6	52.0
14	51.3	52.0	52.0
15	51.3	51.7	52.0
16	31.6	33.7	32.0
17	31.6	32.6	32.0
18	31.6	32.6	32.0
19	20.0	20.4	20.0
20	20.0	20.4	20.0
21	20.0	19.4	20.0
22	12.6	13.4	13.0
23	12.6	11.9	13.0
24	12.6	12.5	13.0
25	0.9	0.5	1.0
26	0.9	0.2	1.0
27	0.9	0.2	1.0

A plot of the computer determined data vs the expected values is shown in Figure 1 along with the regression line. Likewise, Figure 2 shows a plot of the strip chart values vs the expected values and the regression line. Information on both regressions are listed with their respective figures.

The figures show excellent agreement between the expected and measured transmission values. Both show R squared values of 99.9%.

As requested by U.S. Testing, the experimental data is also shown in Table 3 in terms of the extinction coefficient, defined here as:

$$\text{Ext. Coef.} = -\ln(T).$$

This table shows that significant differences between the expected and measured values can occur when the amount of light transmitted through the system becomes close to zero (a very dense smoke). This is due to the nature of the natural logarithm function.

TABLE 3

Run	Expected Ext. Coef.	Measured Ext. Coef. (Computer)	Measured Ext. Coef. (Strip Chart)
1	-	-	-
2	-	-	-
3	-	5.73	-
4	0.00	-0.05	0.00
5	0.00	-0.01	0.00
6	0.00	-0.01	0.00
7	0.18	0.18	0.17
8	0.18	0.16	0.17
9	0.18	0.16	0.17
10	0.48	0.45	0.49
11	0.48	0.49	0.49
12	0.48	0.45	0.49
13	0.67	0.64	0.65
14	0.67	0.65	0.65
15	0.67	0.66	0.65
16	1.15	1.09	1.14
17	1.15	1.12	1.14
18	1.15	1.12	1.14
19	1.61	1.59	1.61
20	1.61	1.59	1.61
21	1.61	1.64	1.61
22	2.07	2.01	2.04
23	2.07	2.13	2.04
24	2.07	2.08	2.04
25	4.67	5.30	4.61
26	4.67	6.26	4.61
27	4.67	6.08	4.61

cc: R. Comes
R. Ferguson
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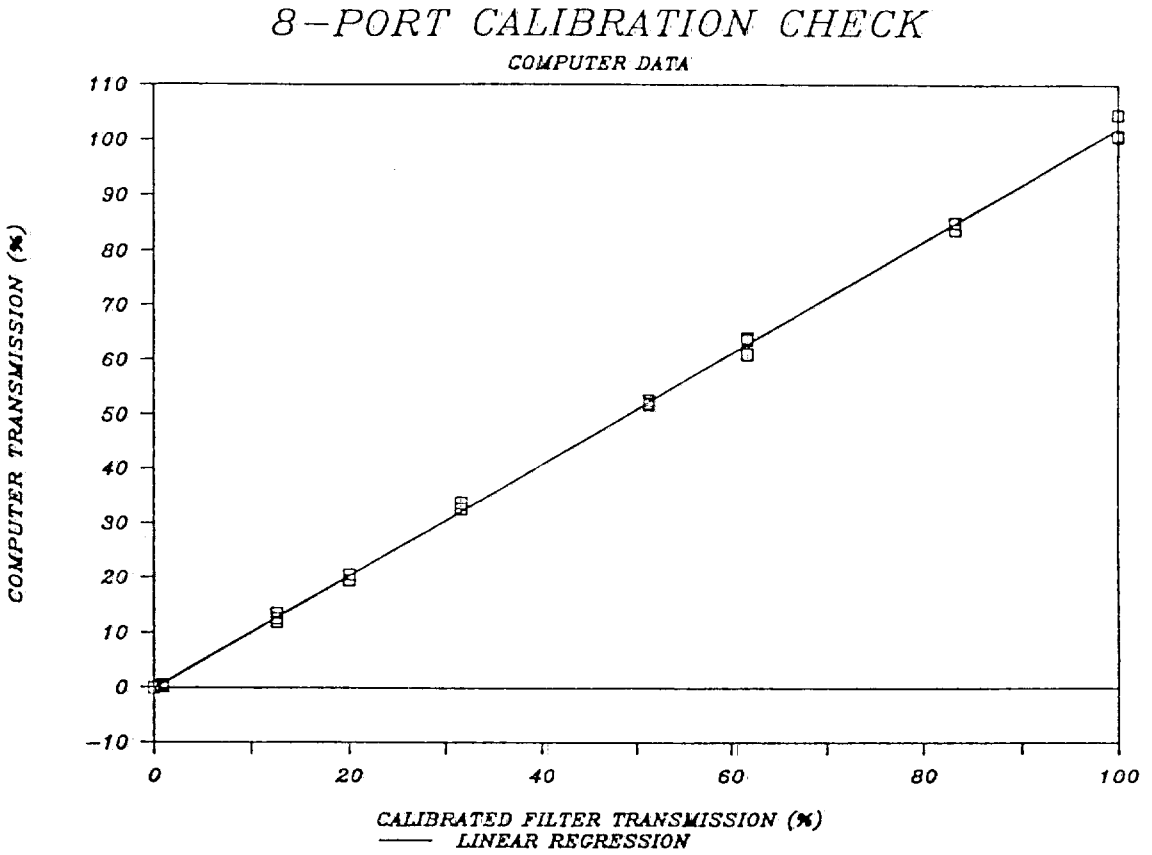

FIGURE 1. Plot of the computer determined transmission values as a function of the expected transmission values. Points: data, Line: linear regression.

Linear regression information:

Intercept:	-0.23
Slope:	1.0228
R squared:	0.9992

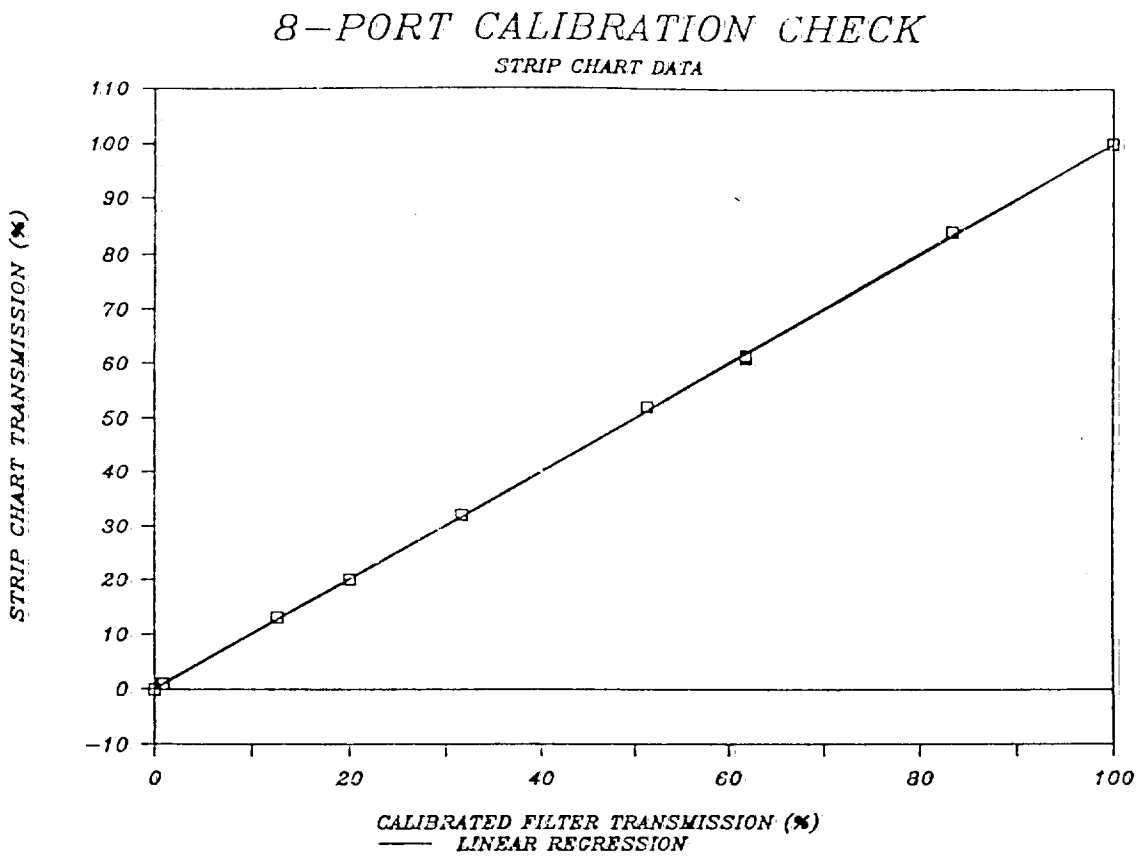

FIGURE 2. Plot of the strip chart transmission values as a function of the expected transmission values. Points: data, Line: linear regression.

Linear regression information:

Intercept:	0.16
Slope:	1.0015
R squared:	0.9999